The abundance of *E. coli* in *Cladophora* mats at Lake Michigan beaches

Erika Jensen, M.S.
Great Lakes WATER Institute
University of Wisconsin-Milwaukee

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Presentation Outline

- What is *E. coli* and why do we care?
- Sample locations/strategy
- General overview of *Cladophora*
- *E. coli* die off study
- Source tracking techniques
- Future research directions

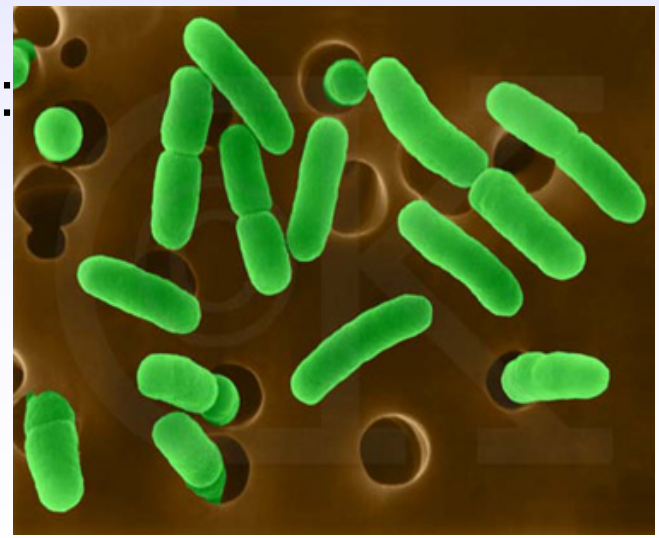
E. coli: an indicator of human health risk

EPA recommended indicator of fecal contamination-
present in high numbers in almost all warm blooded animals

Indicates the presence of enteroviruses, Norwalk viruses, Coxsakie A and B, Hepatitis A, *Shigella* spp., *Salmonella* spp.

Animal sources may also be a concern: *E. coli* O157:H7, *Salmonella spp*.

Does not differentiate between sources (animal vs. human)



Potential Sources of *E. coli*

- CSOs, SSOs, and septic systems
- Stormwater and agricultural runoff
- Waterfowl, domestic pets, and wildlife
- Sand, algae, and interstitial waters

250,000-500,000 CFU/100ml

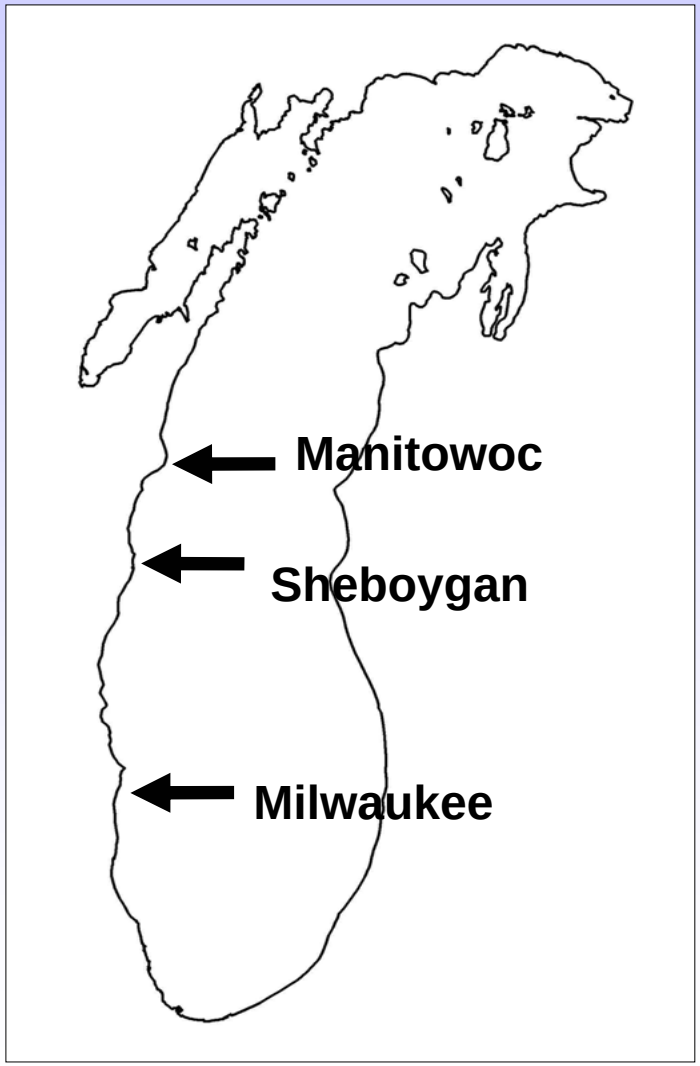
Beach closure 235 CFU/100ml

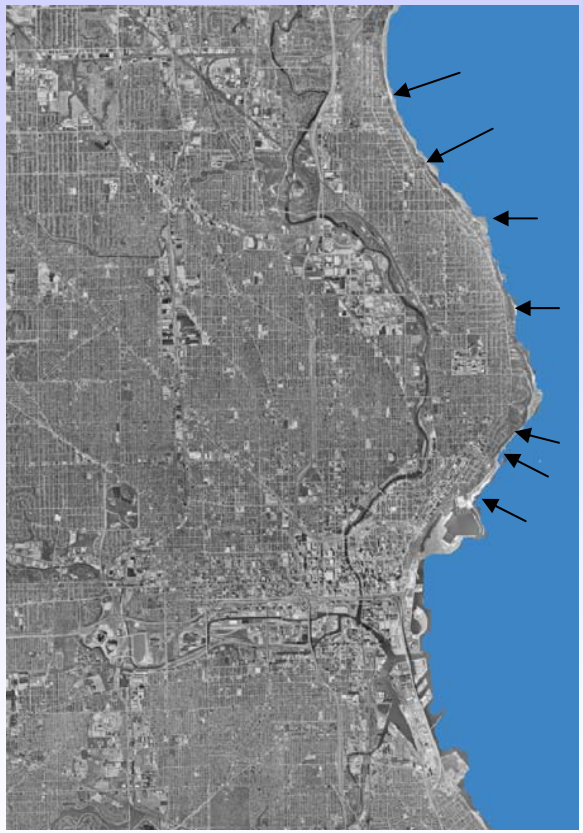
240,000 CFU/100 ml

10,000-100,000 CFU/ml

368,000,000 CFU/g feces

Sample Locations





Milwaukee County Beaches

Link between *Cladophora and E. coli*

- *Cladophora* wash ashore they carry with them large numbers of zebra mussels and small crustaceans that shelter in the algae.

- The mussels and crustaceans may contribute to the odor as they decompose and/or become food for waterfowl.

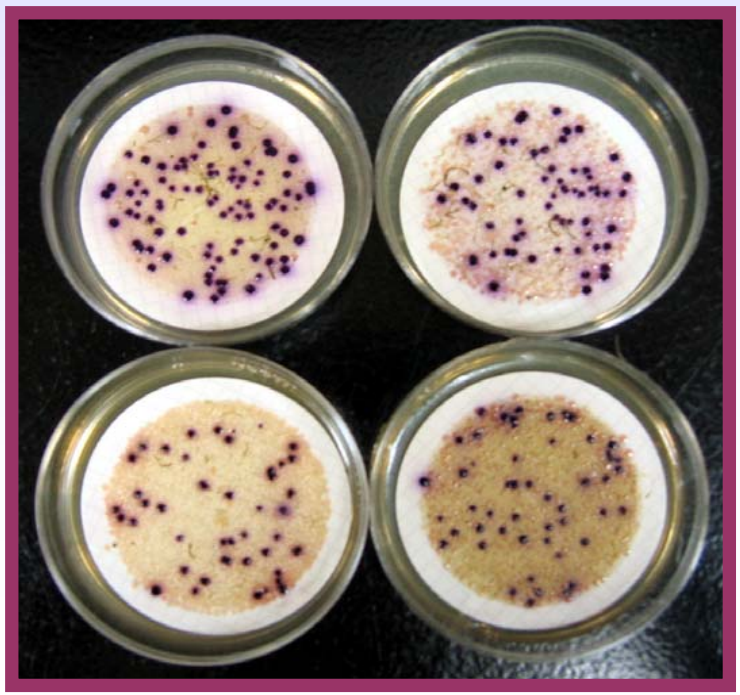
- The higher concentration of birds results in considerably more fecal material, which contains high concentrations of the bacteria *E. coli.*

Methods

- Sample collection 8/27/04 – 11/28/04
- 9 sites along Lake Michigan in WI
- Algal samples were collected from:
  - Water
  - Rocks
  - Sand
- Matching water samples

Vacuum Pump Filter Manifold

E. Coli isolates from *Cladophora* samples grown on Modified m-TEC media



Results

- 7 out of 9 beach sites contained levels of *E. coli* exceeding the recommended USEPA limit of 235/100ml.
- *Cladophora* samples that were green and fresh contained few to no *E. coli*.
- *Cladophora* from decaying mats along the shore contained substantially higher counts.

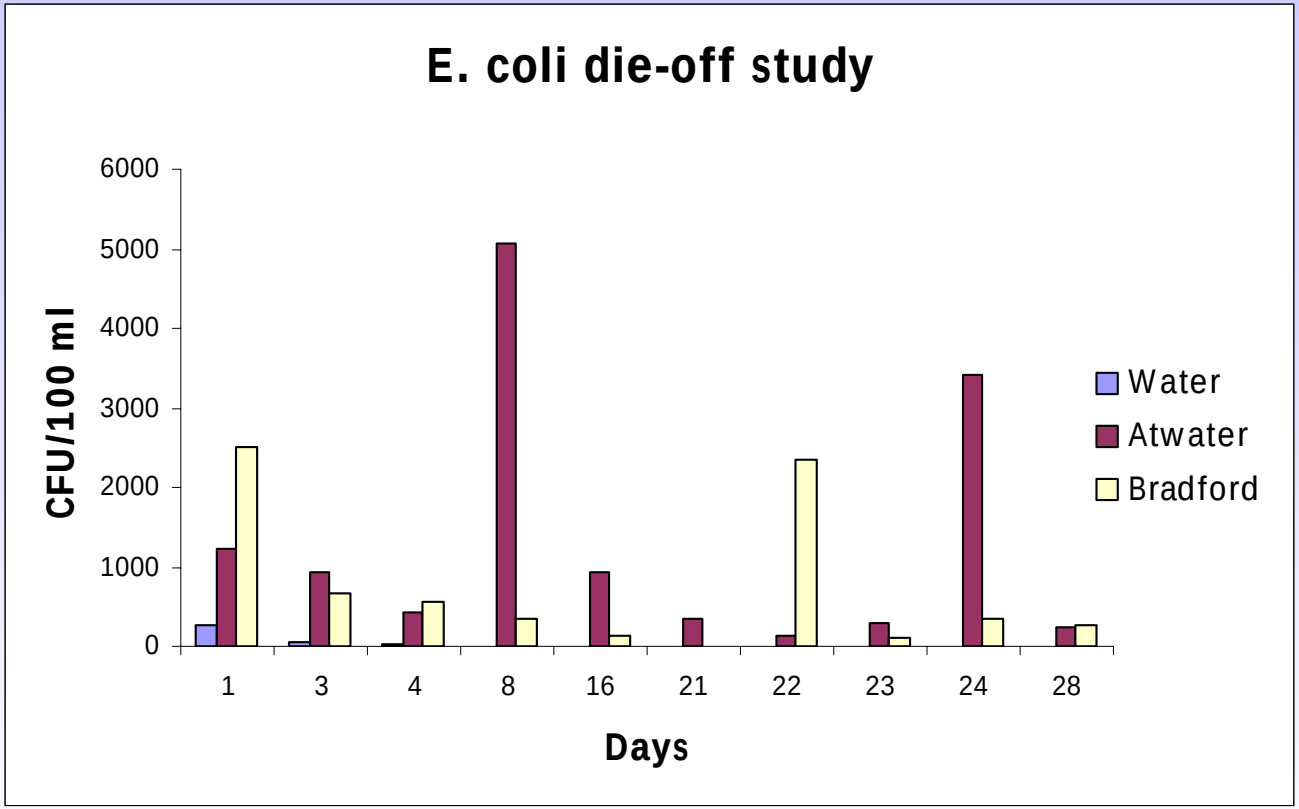
Average *E. coli* levels measured in *Cladophora* samples collected at beach sites along Lake Michigan.

Sample Site	***Number of Samples Collected***	***Average* E. coli *levels in Cladophora Samples (CFU/100ml)***
Atwater Beach	8	3790
Big Bay Beach	1	350
Bradford Beach	20	3440
Doctors Park	1	350
Fischer Beach	12	1725
Klode Park	1	900
Lake Drive	1	150
McKinley Beach	1	115
Beach Drive	1	3200

E. Coli Survival study

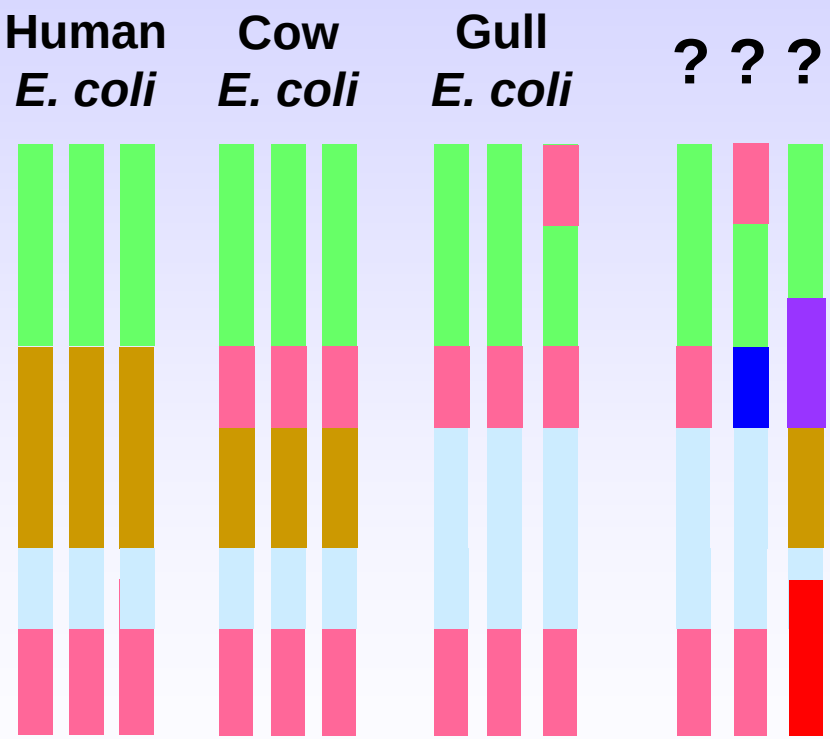
- *Cladophora* placed in covered beaker at room temperature.
- Water samples from matching sites also placed in covered beaker at room temperature.
- Water samples were pipetted from each beaker 3x a week and filtered over a one month period.

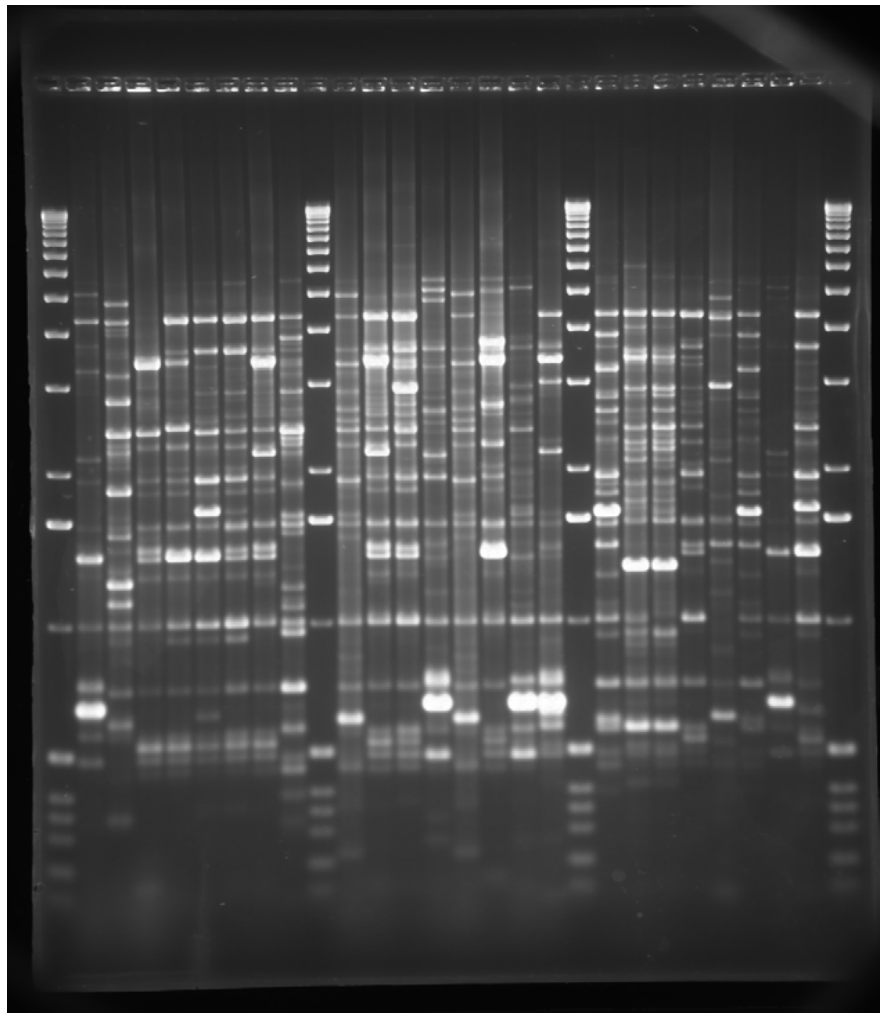
E. coli Survival Study



- *Cladophora* maintained *E. coli* for the duration of the one month study.
- Matching water samples *E. coli* died within one week.

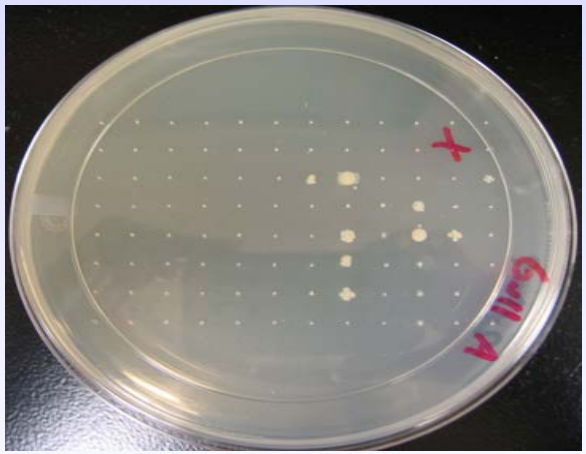
Source Tracking Techniques:
DNA fingerprinting



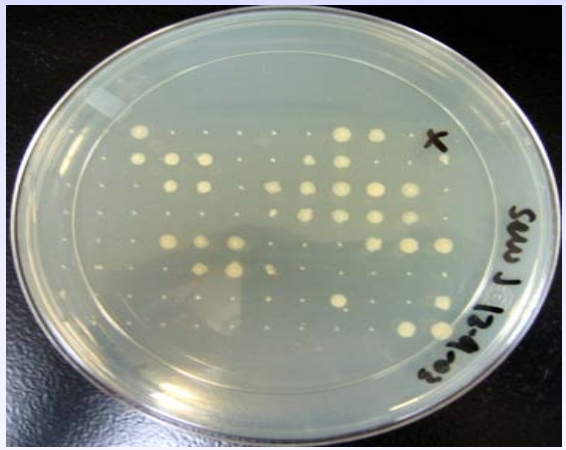


Source Tracking Techniques:
Antibiotic Resistance

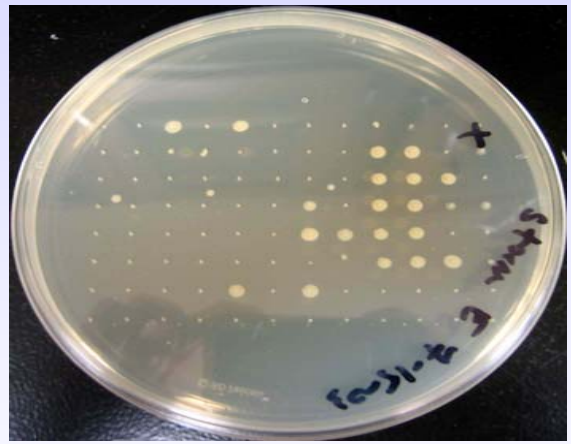
Examples of Ampicillin Plates from different hosts



Gull



Sewage



Stormwater

All isolates grown on LB plates with 20 μg/ml

Antibiotic	% Resistance		
	Sewage (n=1252)	**Gulls (n=1225)**	***Cladophora* (n=1318)**
Ampicillin	50	4	30
Chlorotetracycline	21	2	4
Kanamycin	10	1	3
Nalidixic Acid	12	<0.5	3
Neomycin	8	1	<0.5
Oxytetracycline	27	4	9
Penicillin G	32	7	17
Streptomycin	18	3	7
Sulfathiazole	18	2	8
Tetracycline	24	3	4

Conclusions

- *Cladophora* grows on a variety of substrates (including zebra mussels).

- *Cladophora* attracts gulls and other species of nuisance wildlife because it contains zebra mussels and small crustaceans.

- *E. coli* from fresh *cladophora* samples contained few to no *E. coli*.

- Decaying *cladophora* mats contained substantially higher counts.

Future Research

- Expand our existing dataset include more sample sites and isolates.
- Lengthier survival studies.
- Use *Bacteroides* and other molecular techniques to distinguish bacterial host sources in algal mats.
- Conduct a bacterial community profile of *Cladophora* mats to determine which species may contribute to the odor.

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